SAFE AND AUTOMATIC METHOD FOR REMOVAL OF COKE FROM A COKE VESSEL

FIELD OF THE INVENTION

The present invention relates to the field of hydrocarbon processing and, in particular, to heavy hydrocarbon processing in coke vessels.

BACKGROUND OF THE INVENTION

Many oil refineries recover valuable products from the heavy residual hydrocarbons (commonly referred to as resid or residuum), which remain following initial refining, by a thermal cracking process known as delayed coking. Generally, the delayed coking process involves heating the heavy hydrocarbon feed from a fractionation unit, then pumping the heated heavy feed into a large steel vessel commonly known as a coke drum. The unvaporized portion of the heated heavy feed settles out in the coke vessel where the combined effect of retention time and temperature causes the formation of coke. Vapors from the top of the coke vessel, which typically consist of steam, gas, naphtha and gas oils, are returned to the base of the fractionation unit for further processing into desired light hydrocarbon products. The operating conditions of delayed coking can be quite severe. Normal operating pressures in coke vessels typically range from 25 to about 50 pounds per square inch and the heavy feed input temperature may vary between 900°F and 950°F. The coke drums operate in pairs, with one drum feeding residuum and the other drum undergoing the "decoking" sequential steps. The drums typically operate on a cycle, switching every 12-30 hours.

Coke vessels are typically large, cylindrical vessels commonly 19 to 30 feet in diameter and two to three times as tall having a top head and a funnel shaped bottom portion fitted with a bottom head and are usually present in pairs so that they can be operated alternately. Coke settles out and accumulates in the vessel until it is filled to a safe margin, at which time the heated feed is

switched to the empty "sister" coke vessel. Thus, while one coke vessel is being filled with heated residual oil, the other vessel is being cooled and purged of hundreds to thousands of tons of coke formed in the vessel during the previous recovery cycle. The full vessel is isolated, steamed to remove hydrocarbon vapors, cooled by filling with water, drained, opened, and the coke is removed.

Coke removal, also known as decoking, begins with a quench step in which steam and then water are introduced into the coke filled vessel to complete the recovery of volatile, light hydrocarbons and to cool the mass of coke. The vessel is then vented to atmospheric pressure. Decoking is accomplished at most plants using a hydraulic system consisting of a drill stem and drill bit that direct high pressure water jets into the coke bed. To cut coke in this manner the top and bottom heads of the vessel must be removed. A rotating combination drill bit, referred to as the cutting tool, is about 18 inches in diameter with four (4) nozzels and is mounted on the lower end of a long hollow drill rod about 6 inches in diameter. The drill bit is lowered into the vessel, on the drill stem, through a flanged opening at the top of the vessel. A "bore hole" is drilled through the coke using the four nozzles angled approximately 60 degrees down from horizontal. This creates a hole from about 3 to 6 feet in diameter for the coke to fall through. There is normally a naturally occurring small hole in the coke bed for the initial pass because the resid flows in from the bottom and out toward the edges of the vessel.

When the initial bore hole is complete, the drill bit is then mechanically switched to two (2) horizontal nozzles in preparation for cutting the "blow" hole, which extends to the full drum diameter. The nozzles shoot jets of water horizontally outwards, rotating slowly with the drill rod, and those jets cut the coke into pieces, which fall out the open bottom of the vessel, into a chute that directs the coke to a receiving area. At some plants the hydraulic drill is raised slowly up from the bottom the entire vertical height of the coke mass, at others the drill is lowered from the top through the mass and at still other plants the coke mass is first cut from the bottom cone of the vessel and the remainder is cut from the top of the vessel. In any case, the cut coke falls out

the opening at the bottom of the vessel into the coke chute system. The drill rod is then withdrawn out the flanged opening at the top of the vessel. Finally, the top and bottom of the vessel are closed by replacing the head units, flanges or other closure devices employed on the vessel unit. The vessel is then clean and ready for the next filling cycle with the heavy hydrocarbon feed.

The process of removing and replacing the removable top head and bottom units of the vessel cover is called heading and unheading or deheading. It is dangerous work, with several risks associated with the procedures. There have been fatalities and many serious injuries. There is significant safety risk from exposure to steam, hot water, fires and repetitive stress associated with the manual unbolting work. Accordingly, the industry has devoted substantial time and investment in developing semi-automatic or fully automatic unheading systems, with attention focused on bottom unheading where the greatest safety hazard is present.

There are two typical and commonly used methods to move the bottom head out of the way of the falling coke. The first is to completely remove the head from the vessel, perhaps carrying it away from the vessel on a cart. This process may be automated as set forth in U.S. Pat. No. 5,336,375. The other way of "removing" the bottom head is to swing it out of the way, as on a hinge or pivot, while the head is still coupled to the vessel as in U.S. Patent No. 6,264,829. Several U.S. patents disclose various methods and apparatus for detaching and laterally moving a drum head or swinging away a drum head including: U.S. Pat. No. 6,264,829 (discloses a swing away hydraulically operated drumhead adapted for low headroom situations); U.S. Pat. No. 6,254,733 (depicting in the drawings a hydraulically removable drumhead); U.S. Pat. No. 6,066,237 and 5,876,568 (disclosing an apparatus for semi-automatically clamping and unclamping a drum bottom head); U.S. Pat. No. 5,947,674 (a drum head device removed by vertically oriented hydraulic cylinders adapted for lowering the head unit and moving it laterally aside); U.S. Pat. No. 5,785,843 (claims a process involving a swing away hydraulically operated drumhead adapted for low headroom situations); U.S.

Pat. No. 5,581,864 (a remotely operated carriage mounted drumhead removal system); U.S. Pat. No. 5,500,094 (car mounted drumhead removal system that is horizontally movable); U.S. Pat. No. 5,228,825 (a device and method for deheading a drum comprising, in part, a cradle that holds the drum head for removal); U.S. Pat. No. 5,221,019 (a remotely operated cart removal system); U.S. Pat. No. 5,098,524 (a pivotally attached unheading device associated with clamps); U.S. Pat. No. 4,726,109 (a platform device lowers the drumhead and moves it laterally away). These systems all use a manual or semi-automatic bolting system that must be uncoupled with every decoking cycle.

The above described bottom head removal systems all require that the heated feed enter the coke vessel from the bottom through the center of the bottom head. Although in past years there have been some side entries used, except for possibly one or two cases, side entry use has been discontinued in coker vessels built and put into operation in the last 20 to 30 or more years. Thus, in the usual coker operation, to remove the vessel bottom head for decoking the feed line must first be disconnected before the bottom head can be removed. Lastly a coke chute must be manually or hydraulically moved into place and, typically, safety bolts are manually inserted to secure the chute to the drum, allowing the chute to receive the falling coke. The chute directs the coke, as it is drilled out of the vessel, to a receiving area where it is later removed. These methods still require the feed line to be opened up and the head removed before the bottom chute can be brought up and attached to the bottom flange of the vessel.

Considering that there is exposure to personnel and/or equipment when opening the feed line, and considering there is exposure to personnel and/or equipment when opening the bottom head before the chute comes up and is attached, and considering there may still be personnel exposure to steam/hot water between the chute and bottom head after the chute is up, improvements in coke vessel bottom unheading system to allow safe removal of coke from the vessel is highly desirable. The object of the present invention is to address this need.

SUMMARY OF THE INVENTION

According to the present invention, a process and apparatus are provided for repetitively producing and removing coke from a delayed coker vessel without unheading the vessel bottom, wherein the coker vessel has a bottom portion having an aperture through which coke is released, comprising: (a) sealing an aperture closure housing to the bottom portion of the coker vessel; (b) moving a closure member within the closure housing to close the aperture; (c) feeding a heavy hydrocarbon feed into the coker vessel through a feed line attached to the coker vessel at a position above the bottom of the coker vessel; (d) coking the heavy hydrocarbon in the coker vessel; (e) moving the closure member within the closure housing to open the aperture to allow coke removal from the coker vessel; (f) releasing coke through the aperture into a coke chute, and; repeating steps c through f, successively. In a preferred embodiment of the invention the closure member is power actuated, such as hydraulically, by remote means, thus obviating any need for personnel to be physically present in the vessel bottom area during decoking operations.

The delayed coker vessel of the present invention comprises a vessel having a top opening and on the lower portion a side aperture and a bottom aperture; a feed pipe fitted to said side aperture; a bottom aperture closure housing sealed to the bottom aperture; a closure member moveable within said closure housing; a coke chute sealed to the bottom portion of the closure housing for directing material from the vessel to a receiving area. The combination of the closure housing and moveable closure member therein is herein termed a closure unit or valve. In one embodiment of the invention the bottom portion of the coker vessel is designed and fabricated to be directly sealed to the closure unit, whereas in another embodiment, particularly useful for retrofitting existing coker vessels, a bottom transition piece, herein termed a spool, is interposed between the vessel bottom and the closure unit and pressure-tightly sealed to both. In either of these two embodiments, a preferred feature is that the closure housing is pressure-tightly sealed to either (a) the coker vessel or (b) the spool piece. Preferably the pressure-tight seals

will withstand pressures within the range of about 100 psi to 200 psi, preferably within the range of about 125 psi to about 175 psi and most preferably between about 130 psi to about 160 psi and thereby preclude substantial leakage of the coker vessel contents including during operation thereof at temperature ranges between about 900°F and 1000°F. In embodiment (b) the spool preferably has a side aperture and flanged conduit to which the hydrocarbon feed line is attached and sealed.

The present invention substantially reduces or eliminates the dangerous and time consuming procedure of heading and unheading delayed coker vessels, thus rendering the decoking procedure safer for personnel to perform by insulating them from exposure to tons of hot, falling coke, high pressure steam, scalding water, mobile heavy equipment and other extreme hazards. Among other factors, the present invention is based on our conception and finding that coke is safely and efficiently removed from a delayed coker vessel by the closed system process described herein, sometimes visualized by us as a "closed-pipe" system, which includes side entry for the feed to the vessel and a pressure-tight seal between a closure housing for a vessel bottom aperture. The vessel bottom aperture, which opens and closes, preferably includes automatic and remote operation of a closure unit, such as a valve, located at the bottom of the coker vessel rather than unbolting and removing or swinging away a “head” as in the prior art. One aspect of enabling the process of the present invention is introducing the heated hydrocarbon feed to the coker vessel at a location above and lateral to the coker vessel bottom and the closure unit, in combination with the above mentioned pressure-tight seals.

A preferred embodiment of the present invention is additionally based on our finding that coke removal in the present process is advantageously carried out using a coke chute bolted and pressure-tightly sealed to the bottom of the closure housing. The chute, which preferably remains attached without removal throughout repetitive coking/decoking cycles, assists in directing coke removed from the coker vessel to a coke receiving area.

According to a preferred embodiment, the invention further relates to a method and apparatus for automatically opening and closing a vessel bottom aperture by means of a closure unit or valve, in lieu of the removable or partially removable head devices described in the prior art, and without the associated safety and efficiency drawbacks discussed above. In a preferred embodiment, which takes the place of the prior art removable closure flanges, spool pieces bolted to stationary vessel flanges, hinged flanges, carts, carriages and the like, powered devices, which may be controlled automatically, move closure a closure member within a closure housing between open and closed positions. These powered devices may comprise any powered actuators, including motors, solenoids, or the like, but preferably comprise linear actuators such as hydraulic or pneumatic cylinders with reciprocating piston rods. Such actuators may be mounted on the vessel the closure housing or other stationary location to reversibly and repetitively move the closure member from an open to closed position. Preferably the method of the invention does not typically require direct human intervention in proximity to the vessel bottom to actuate the powered devices, which is preferably accomplished by remote instrumentation means such as an electronic relay system or computer controlled system. The entire process is, thus, done safely and without significant or dangerous physical effort.

Although secondary to the significant safety improvements, the present invention also speeds up the procedure so that the coking/decoking cycle time can be substantially reduced, without compromise in safety or human effort. The invention also renders the addition of this new closure device onto the hundreds of existing coker vessels to a relatively simple, quick, and inexpensive procedure, as compared to the difficult, expensive, and time consuming requirement of the existing methods and devices of the prior art described above.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic diagram of the delayed coking process of the present invention. Figure 2 is a side view of a typical coke vessel bottom known in the

prior art depicting the typical bottom entry feed, removable vessel bottom head in one of the known arrangements and detachable coke chute arrangement in one of the known arrangements. Figure 3 is a side view depiction of a preferred embodiment of the present invention illustrating a coker vessel designed and fabricated to be directly attached and sealed to the closure housing and the side entry hydrocarbon feed line. Figure 4 is a side view depiction of another embodiment of the invention, particularly useful for retrofitting existing coker vessels, showing a spool or flange interposed between the coker vessel bottom and the closure housing. Figures 3 and 4 additionally depict a coke chute affixed and sealed to the closure housing bottom. Figures 5 and 6 depict top and side views of the coke vessel closure unit with cut-a-way portions showing the movable closure member within the closure housing.

DETAILED DESCRIPTION OF THE INVENTION

The invention relates to an improved method of repetitively coking heavy hydrocarbons in a coker vessel and repetitively decoking the vessel in a rapid, safe and efficient manner by simply opening and closing a closure member, such as a valve, within a closure unit, rather than removing or swinging away a bottom head unit, as in the prior art. As generally depicted in Figure 1, delayed coking is accomplished by charging hot, resid oil feed through a feed line **10** to the fractionator **15** above the bottom vapor zone **20.** Lighter hydrocarbon materials such as naphtha, gases, diesel and gas oils are taken from upper portions of the fractionator vessel **15** by appropriately placed conduits **25**, **30**, **35** and routed to other facilities for further refining.

Fresh feed and recycled feed from the bottom of the fractionator **15** are pumped through a coker heater **40** where the combined feed is heated to a temperature ranging between about 900°F to1000°F, preferably to between 905°F to 950°F and most preferably to between 910°F and 935°F, partially vaporized and alternatively charged to one of a pair of coker vessels **45, 45a** via a feed line **50, 50a** laterally attached to the coker vessel **45, 45a**. Hot vapors from the top of the coker vessels **45, 45a** are recycled to the bottom of

the fractionator **15** via a feed line **55.** In this manner, the hot vapors from the coke vessel are quenched by the cooler feed liquid, thus preventing any significant amount of coke formation in the fractionator **15** and simultaneously condensing a portion of the heavy ends which are recycled to the coker vessels **45, 45a**. The unvaporized portion of the coker heater effluent settles out (cokes) in the active coker vessel **45, 45a** where the combined effect of temperature and retention time results in coke formation. Coke formation in the coker vessel **45, 45a** is continued, typically between about 12 to about 30 hours, until the active vessel **45, 45a** is full to within a safe margin from the vessel top.

Once the active coke vessel **45, 45a** is full, the heated heavy hydrocarbon feed is redirected to the empty coker vessel **45, 45a** where the above described process is repeated. Coke is then removed from the full vessel by first quenching the hot coke with steam and water, then opening a closure unit **60** sealed to the vessel bottom, hydraulically drilling the coke from the top portion of the vessel and directing drilled coke from the vessel through the open closure unit into a coke chute **65** sealed to the bottom of the closure unit **60** to a coke receiving area **62**. Opening of the closure unit is safely accomplished by a remotely located control unit **70.**

Key features of the coking method and coker vessel of this invention include the side entry feed line **50a** and **50b** (see Figures 3 &4), the closure unit **60**, with a moveable closure member therein, pressure-tightly sealed to the vessel bottom **45, 45a** and a coke chute **65** pressure-tightly sealed to the bottom of the closure unit **60**. The side entry feed line **50b** can be attached to the vessel side from about 6 inches to about 5 feet above the vessel bottom, preferably from 1 foot to about four 4 feet from the vessel bottom and most preferably from 1.5 feet to 2.5 feet from the vessel bottom.

Referring to Figures 3 and 4, said pressure-tight seals are accomplished in one preferred embodiment (Figure 3) preferably by means of a gasket **90** interposed between facing flanged surfaces of the coke vessel bottom **75**, the closure unit **75a** and the coke chute **75b** and the closure unit **75c.** In another

preferred embodiment (Figure 4), a spool piece **80** is used to adapt coke vessel bottom apertures and closure unit **60** apertures of different diameters. In this embodiment said pressure-tight seals are preferably accomplished between facing flanged surfaces of the coke vessel bottom **75**, the spool piece **85**, the closure housing **75a,** the spool piece **85a** and the coke chute **75b** and the closure unit **75c**. To form the pressure tight seals between said flanged surfaces preferably the mating surfaces of the respective flanges are machined to a desired finish, then pressure-tightly joined together with a plurality of suitable fasteners, such as bolts, clamps or similar means and with a carefully selected gasket **90** interposed between said mating surfaces. Similarly, to form the pressure tight seals between the flanged surfaces of the closure housing bottom **75c** and the coke chute **75b** preferably the mating surfaces of the respective flanges are machined to a desired finish, then pressure-tightly joined together with a plurality of suitable fasteners, such as bolts, clamps or similar means and with a carefully selected gasket **90** interposed between said mating surfaces. The method for sealing the coke chute **65** to the closure unit bottom may be different from the method for sealing the vessel or spool to the closure unit top because operating conditions are not a critical factor for seal integrity.

According to a more detailed embodiment, preferably, said flanged surfaces are first machined to an RMS (root mean squared) finish ranging from 50 to 400, preferably 100 to 300 and most preferably between about 120 to 130. An annular gasket comprised of a metal core, such as stainless steal, and a flexible material suitable for use as a gasket in combination with metal under temperatures ranging from -50°F to 1000°F and pressures ranging from 100 psi to 200 psi is fitted to one of the flanged surfaces of each of the coke vessel bottom **75**, the spool piece **85, 85a** and the closure housing **75a**. With the gasket interposed between each, the coke vessel bottom **45**, and the closure housing **60** (and in another embodiment the spool piece **80**) are pressure-tightly joined together by a plurality of suitable fasteners, such as bolts, clamps or similar means. The fastening means, such as bolts, clamps or similar means are tightened or torqued such that the pressure placed on

the gaskets **90** ranges between 10,000 PSI to 30,000 PSI, preferably between 15,000 and 25,000 PSI and most preferably 20,000 PSI. Preferably, said torque pressure is applied evenly around the gasket circumference.

In a preferred embodiment of the present invention the metal gasket is annular and stainless steel ranging in thickness from about .020 " to .140', preferably about .024" to about .035" and most preferably from about .028" to about .032", and is concentrically corrugated. Said corrugations range in height above the metal surface of the gasket from a minimum of about 0.001 inches to a maximum of about 0.050 inches, preferably from a minimum of about 0.005 inches to a maximum of about 0.030 inches and most preferably from a minimum of about 0.010 inches to a maximum of about 0.020 inches. Once corrugated, the width of the gasket is such that the outside and inside diameters thereof are respectively coincident with the outside and inside diameter of the flanged surfaces of the coke vessel bottom, the spool piece, the closure unit and the coke chute. Flexible graphite material, such as Polycarbon flexible graphite Grade B or BP (with antioxidant inhibitor) or Union Carbide flexible graphite grade GTB or GTK (with antioxidant inhibitor), is bonded to the upper and lower surfaces of the gasket metal core such that the gasket is sandwiched between the layers of graphite material. Thickness of the graphite material can range from about 0.005 inches to about 0.030 inches, preferably between 0.010 inches to about 0.025 inches and most preferably is about 0.015 inches thick. Preferably the graphite covering will have the same nominal inside and outside diameter dimensions of the metal gasket. Upon bonding to the gasket metal core surfaces, the corrugations thereof should be covered by the graphite material. Sealing the flanged surfaces of the coker vessel, the spool piece, the closure unit and, optionally, the coke chute in the manner described above results in a pressure-tight seal that tolerates the differential expansion that occurs between the flanges during the repetitive coking/decoking cycles of the present invention.

Figures 3 and 4 depict preferred embodiments of the coker vessel. Figure 3 depicts the lower portion of a coker vessel **45** which can be 15 to 30 feet in diameter and 80 to 100 feet tall, which is typically cone or funnel shaped on

the lower end and which is attached to a lower flange **75** that is typically 60 to 72 inches in diameter. A closure unit **60** is pressure-tightly attached or sealed to the lower flange **75**. The closure unit **60** has a flanged lower portion **75c**, which is pressure-tightly attached or sealed to a coke chute **65**. The closure unit **60** and coke chute **65** remain sealed in place during repetitive coking and decoking cycles, but can be detached and laterally moved away from the vessel **45** for maintenance via a gantry system, trolley system, rail mounted cart or carriage or other similar system. The number of coking cycle repetitions that can be carried out prior to breakdown of the system for major maintenance can vary from 10 to 150 cycles, preferably 20 to 100 cycles and, most preferably, from 30 to 75 cycles per pair of vessels.

Figure 4 depicts another embodiment of the invention that is particularly suitable for retrofitting existing coker vessels. As in the first embodiment the coke vessel **45** is typically cone or funnel shaped on the lower end which is attached to a lower flange unit **75** that is typically 48 to 72 inches in diameter, preferably 60 to 72 inches in diameter. Interposed between the lower flange **75** and the closure housing **60** is a spool piece **80** having a flanged top **85** and bottom **85a** and a laterally attached flanged conduit **50b** for attachment to the heavy hydrocarbon feed line **50a**. The spool piece **80**, in one embodiment, can be of equal diameter on the top and bottom or, in another embodiment, conical in shape to adapt the coker vessel opening diameter to the closure unit opening diameter, for example a vessel opening of about 72 inches and a closure unit opening of about 60 inches in diameter.

Figures 5 and 6 respectively depict plan and side cut-away views of the closure unit of a preferred embodiment of this invention. The closure unit **60** of this invention is a slide, gate, knife, ball, wedge plug or similar type valve comprising a closure housing **115** defining an interior void wherein a closure member **120** is mounted to an actuator or actuators **125**, such as hydraulic pistons **130** such that said closure member can be laterally moved to an open or closed position. The closure housing further comprises a first end section **135**, a second end section **140** and a middle section **145** which middle section defines an aperture **150** that can range in size from 48 to 72 inches in

diameter. When moved laterally within the closure housing **115** the closure member **120** opens and closes said aperture **150**.

To begin the coking cycle described above the closure member **120** is moved laterally to close the vessel bottom by operating the actuators **125**, such as hydraulic cylinders **130** that are, preferably, automatically and remotely operable. When the closure member is moved into the fully closed position the closure housing **115** is purged with nitrogen and/or steam via inlet valves **155** mounted in the closure housing body **115**. Coking then begins by the process described above. During the coking phase of the coking cycle block pressure steam is injected into the closure housing body at a rate sufficient to maintain pressure at a level to effectively eliminate hydrocarbon leaks at the closure member/closure housing seat **160**. Blocking steam pressure and flow rate are continuously monitored during the coking phase by use of pressure and flow rate measuring devices **165** installed in the closure housing **115** and connected to a remotely located control unit **70**.

EXAMPLE

In a coking vessel used for delayed coking of heavy petroleum hydrocarbon feed stocks, after about 24 hours of operation sufficient coke is accumulated in the vessel such that removal of the coke is required before coking operations can continue in the vessel. At this point the heated heavy hydrocarbon feed is redirected to an adjoining empty coke vessel. The full coke vessel which is equipped with a lower spool transition piece, a closure unit and attached coke chute operated in accordance with a preferred embodiment of this invention, is shut down, quenched, depressurized and the closure member within the closure housing unit is hydraulically moved laterally to open the coke vessel bottom. Hydraulic movement of the closure member is actuated by workers from a safe, remotely located control system. Important characteristics of the coker vessel used in preferred embodiments of the present invention that can be repetitively cycled through the coking and decoking process without removing the closure unit and coke chute, include: A coker lower flange equal to 72 inches in diameter; a flanged spool transition

piece wherein the top flange of the spool piece is 72 inches in diameter and the bottom flange is 60 inches in diameter; a hydrocarbon feed inlet line installed laterally on the spool piece; a closure housing with a 60 inch diameter opening therein; a closure member laterally moveable by hydraulic means within the closure housing; a coke chute 60 inches in diameter attached to the bottom opening of the closure housing; and a 60 inch stroke closure member hydraulic actuator powered by a 3000 psi pump.

Referring again to the coking process steps, upon redirection of the hydrocarbon feed from the full coker vessel to the empty coker vessel, 4000 pounds per hour of steam at 150 psi is injected into the full vessel via the laterally installed inlet line. The steam strips uncoked hydrocarbon from the vessel which is routed to the fractionator. After a period of time, usually about two hours, the vessel is isolated from the fractionator and depressurized through a relief system. Stripping steam is thereafter continued for an additional hour and thereafter quench water is added to the vessel at a slow rate to cool the coke bed to approximately 200°F. Upon cooling the vessel to the desired temperature the water is drained from the vessel via the inlet line or by, partially or fully, opening the closure member in the closure housing to drain water from the vessel into the coke receiving area.

Once the coke bed is cooled and the water drained, the vessel is prepared for drilling coke from the vessel with the hydraulic drill system. The closure member within the closure housing is opened hydraulically by remote actuation thereby allowing the drilled coke to fall into the coke chute which is attached to the bottom of the closure housing. As the coke is drilled it falls out of the vessel into the coke chute and is directed into the coke pit. Upon completion of the drilling process the hydraulic drill stem is removed from the top of the vessel, the vessel top head is replaced and the inlet line and coke vessel are visually inspected for plugging. Once the inspection is complete and the removal of coke and absence of plugging is verified, the closure member within the closure housing is hydraulically closed. Then steam is injected into the vessel to purge air and pressure the vessel to test the integrity of the top head seals, inlet line seals, closure housing/vessel/spool

seals, and the closure member seals within the closure housing. Finally, the vessel is preheated to about 400°F to 600°F skin temperature. When the desired temperature is reached the resid hydrocarbon feed is switched into this vessel and the adjoining vessel is prepared for decoking in accordance with the above process.

Thus, according to a preferred embodiment of the present invention, a delayed coking method and coke vessel have been provided which allow the automatic, safe, quick, and effective opening and closure of coke vessels, or the like. While the invention has been herein shown and described in what is presently conceived to be the most practical and preferred embodiment thereof, many other modifications may be made within the scope of the invention, which scope is to be accorded the broadest interpretation of the appended claims so as to encompass all equivalent structures and methods. For example, the structures of the invention may be reduced in size by a factor of two, thus making it about 36 inches in nominal size, inverted, and applied in like form but smaller, to provide the highly desired automation of the flanged closure on the top of the vessel.